Table of Contents

TEVES DSC III MK60

Initial Print Date:10/03/00 Revision Date:10/30/00

TEVES DSC III MK60

Model: E46 (except M3 and Xi) and E36/7

Production Date: From 9/00

Objectives

After completing this module you should be able to:

- Identify the changes of the MK60 over the previous MK20EI system.
- Understand the operation of the new wheel sensors.
- Review the operating principles of ABS, ASC and DSC.
- Describe the new ADB and DBC functions.

Purpose of the system

DSC III MK60 is supplied by Continental Teves and supersedes the Teves DSC III MK20 EI system. The MK60 includes all of the features of the previous system and incorporates two additional functions:

- DBC function
- Modified ADB function

The most important changes from the MK20 EI are:

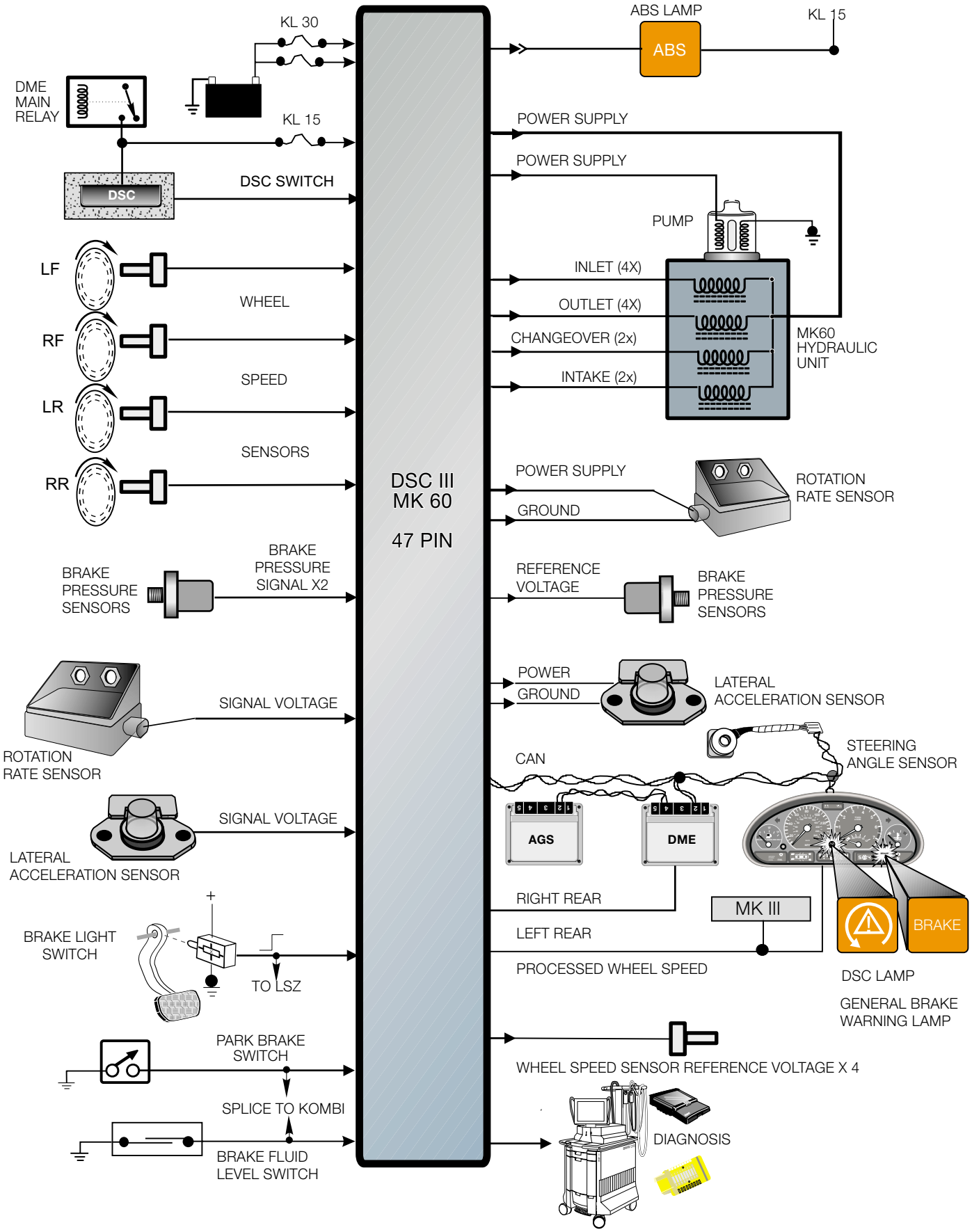
- Reduction in size of the control unit/hydraulic Unit.
- Installation of the hydraulic unit close to the master cylinder.
- Elimination of a pre-charge pump.
- Magneto resistive wheel speed sensors.

The Teves MK60 system is designed to maintain the vehicles stability during:

- ABS braking regulation
- ASC+T traction control
- DSC for oversteer and understeer control

Additional features are also programmed into the control module to enhance driver safety and comfort. These features are:

- **CBC** Corner Brake Control
- **EBV** Electronic Brake Proportioning
- **MSR** Engine Drag Torque Regulation
- **ADB** Automatic Differential Brake
- **DBS** Dynamic Brake System


KL 30
DME
MAIN
RELAY
KL 15
DSC
DSC SWITCH
LF
RF
LR
RR
WHEEL
SPEED
SENSORS
BRAKE
PRESSURE
SENSORS
BRAKE
PRESSURE
SIGNAL X2
ROTATION
RATE SENSOR
SIGNAL VOLTAGE
LATERAL
ACCELERATION SENSOR
SIGNAL VOLTAGE
BRAKE LIGHT
SWITCH
TO LSZ
PARK BRAKE
SWITCH
SPLICE TO KOMBI
BRAKE FLUID
LEVEL SWITCH
DSC III
MK 60
47 PIN
ABS LAMP
ABS
KL 15
POWER SUPPLY
POWER SUPPLY
PUMP
INLET (4X)
OUTLET (4X)
CHANGEOVER (2x)
INTAKE (2x)
MK60
HYDRAULIC
UNIT
POWER SUPPLY
GROUND
ROTATION
RATE SENSOR
REFERENCE
VOLTAGE
BRAKE
PRESSURE
SENSORS
POWER
GROUND
LATERAL
ACCELERATION SENSOR
STEERING
ANGLE SENSOR
CAN
AGS
DME
RIGHT REAR
LEFT REAR
MK III
PROCESSED WHEEL SPEED
BRAKE
DSC LAMP
GENERAL BRAKE
WARNING LAMP
WHEEL SPEED SENSOR REFERENCE VOLTAGE X 4
DIAGNOSIS

System Components

The Teves DSC III MK60 consists of the following components:

- Integrated Control unit/Hydraulic unit with CAN Interface
- Tandem Master Brake Cylinder
- Brake Expansion Tank with Fluid Level Reed Contact in Cap
- 2 Brake Pressure Sensors
- Brake Light Switch
- 4 Wheel Speed Sensors (active)
- Rotation Rate Sensor (yaw)
- Steering Angle Sensor (LEW)
- Transverse Acceleration Sensor
- DSC Button (part of SZM)
- Instrument cluster Warning indicators
- Hand brake Switch
- Wiring Harness

Control Unit/Hydraulic Unit

The MK60 control unit/hydraulic unit is located in the engine compartment on the left side under the brake master cylinder.

Both the control unit and the hydraulic unit are replaceable as separate components.

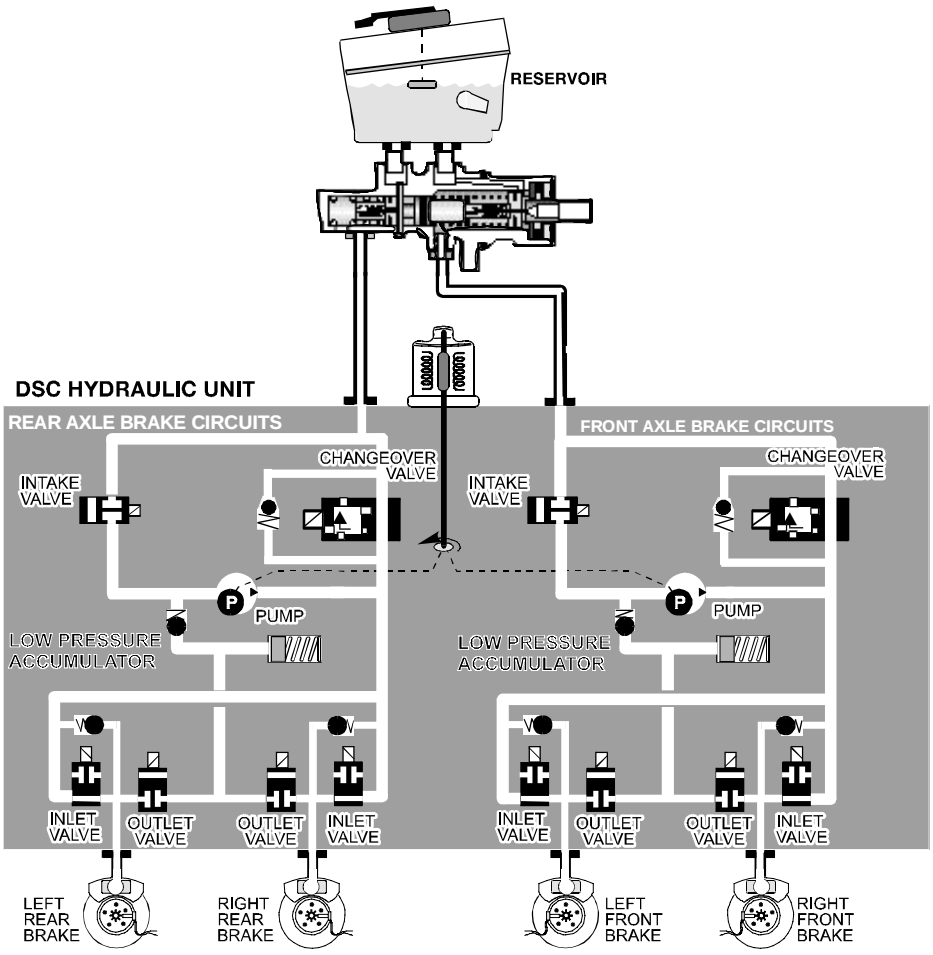
The pre-charge pump used on previous systems is no longer required. Rapid pressure build up is possible because of the close proximity of the hydraulic unit to the master cylinder and improvements in the design of the return pump.

The control unit/hydraulic unit itself is 20% smaller and lighter than the previous MK20 EI.

All processing functions for ABS, ASC or DSC are performed by the combined control unit/hydraulic unit. The MK 60 control unit is also responsible for processing the wheel speed signals and providing them to other control units.

The MK60 control unit for MY 2002 incorporates the RDW function into its scope of control, making a separate RDW control unit unnecessary. The operating principle continues to be based on the analysis of wheel speed.

MK60 Hydraulic Unit



The hydraulic unit consists of an aluminum block containing 12 solenoid valves, 2 pressure accumulators and the return pump.

- 4 inlet solenoid valves (N/O)
- 2 changeover solenoid valves (N/O)
- 4 outlet solenoid valves (N/C)
- 2 Intake solenoid valves (N/C)

The solenoid valving ensures that normal braking is possible in the event of a defective control unit.

In ABS regulation the pump returns fluid back to the master cylinder circuits. In ASC/DSC regulation with brake intervention, the pump is responsible for building up the brake pressure required for the front and rear hydraulic circuits.

Note:
N/O= Normally Open
N/C= Normally Closed

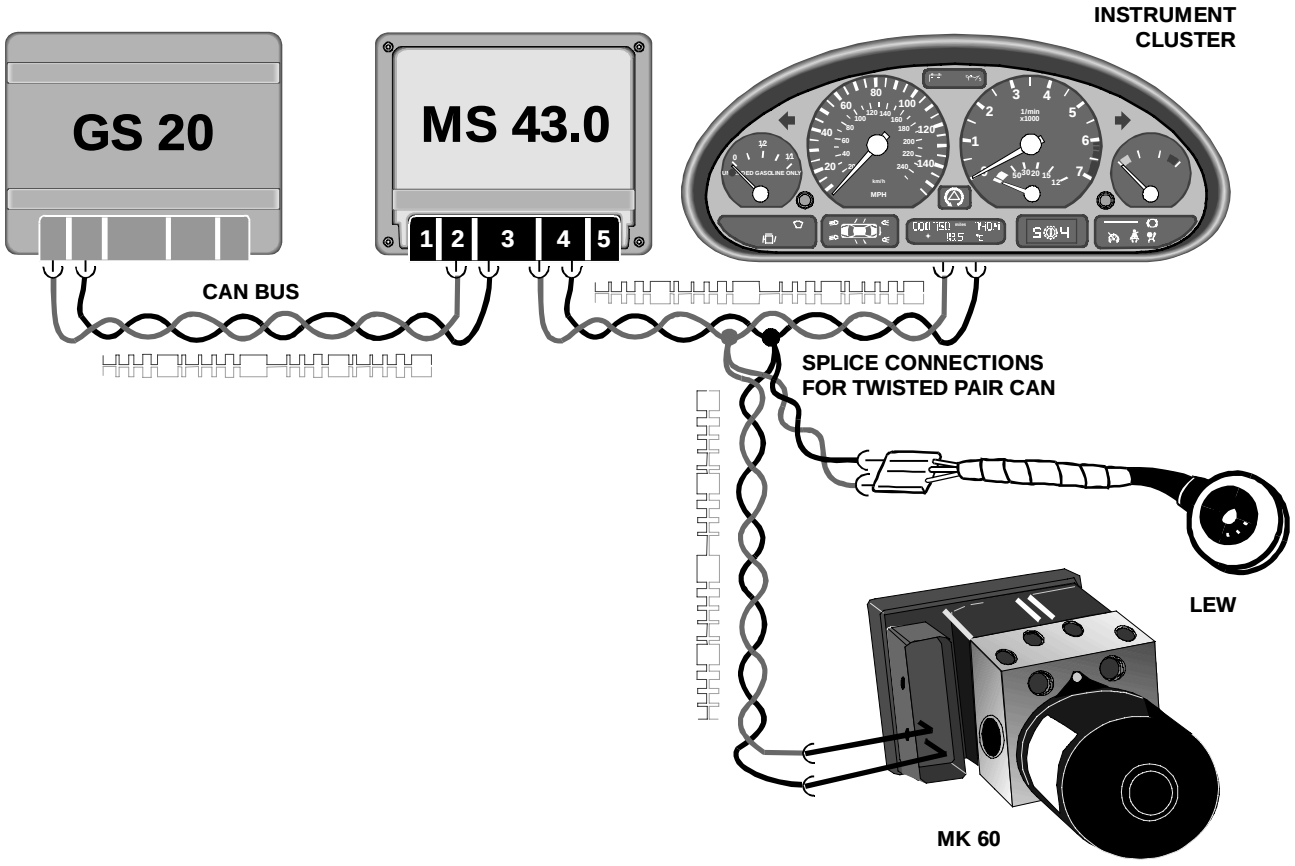
CAN Interface

The MK60 is connected to the CAN bus for communication with the AGS, DME control module, Steering Angle Sensor and the Instrument Cluster.

The CAN bus allows all of the connected control modules to send and receive information and commands.

Communication with the MK60 includes:

- **DME** - The DME sends current engine torque. MK60 commands the DME to reduce (ASC/DSC) or raise (MSR) engine torque.
- **AGS** - The MK60 commands the AGS to suppress shifts during regulation.
- **LEW** - The MK60 receives steering angle information.
- **KOMBI** - The MK60 commands the instrument cluster to activate or deactivate the warning lamps.
- All four wheels speed signals are sent over the CAN bus for use by other modules.



Tandem Master Brake Cylinder

The MK60 system uses a tandem master brake cylinder fitted with central valves as in other DSC master cylinders. The central valves allow fluid to be drawn through the master cylinder during ASC and DSC regulation. The hydraulic circuit is divided front/rear.

An inlet for pre-charge pressure is no longer used since the charge pump has been eliminated from the MK60.

Both brake pressure sensors are mounted on the master cylinder.

Expansion Tank and Brake Fluid Level Switch

The brake fluid expansion tank has internal baffles that reduce foaming during return pump operation.

The expansion tank includes a pick-up tube for clutch master cylinder fluid supply.

The brake fluid level switch is incorporated into the cap. The switch is a reed contact switch. If the brake fluid is at a sufficient level, the switch is closed and switched to ground.

If the fluid level drops below a specified level , the reed contacts open and the MK 60 responds by switching off the ASC/DSC functions.

Normal braking and ABS operation is unaffected.

Brake Pressure Sensors

Two brake pressure sensors are mounted on the master cylinder below the outlet ports for the front and rear brake circuits. The sensors are provided a 5V reference voltage by the MK 60 control unit.

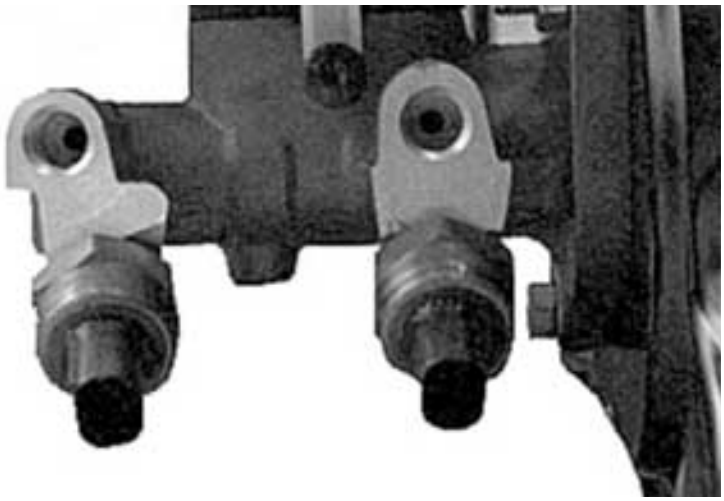
The sensor provides the control unit with an analog signal proportional to brake pressure. Voltage increases with increasing brake pressure.

Plausibility with BLS

The signal input from the brake light switch is compared with the pressure sensor values.

The pressure sensors must not detect more that 5 bar when the BLS is not actuated.

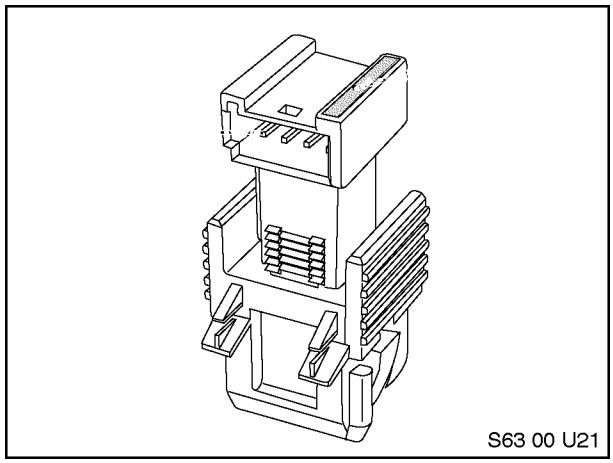
Both signals are used to form a redundant BLS input which is constantly monitored.



Note: Refer to the Workshop Hints for instructions on initializing the brake pressure sensors.

Brake Light Switch (BLS)

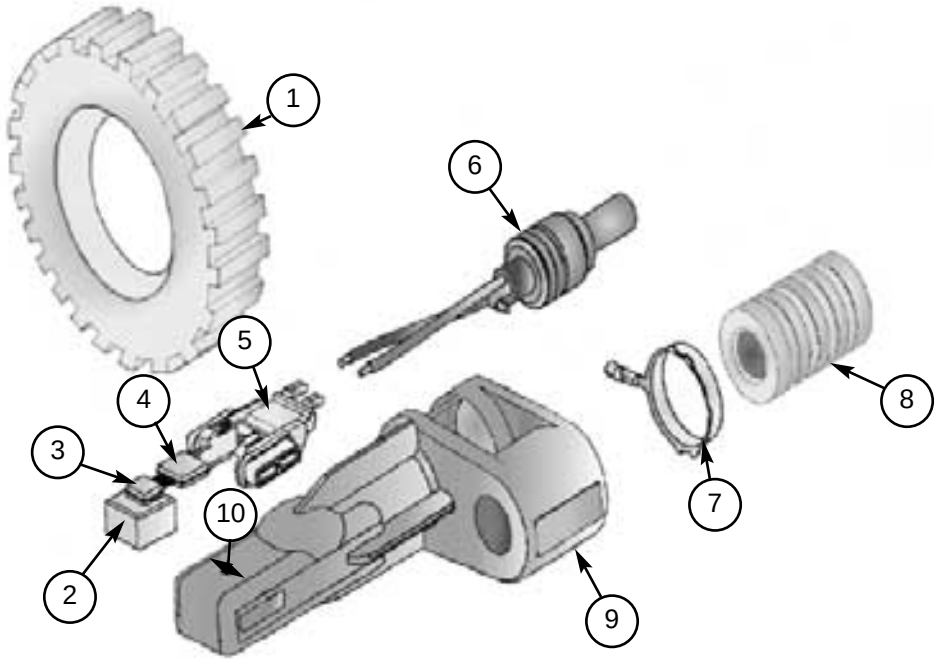
The brake switch is an input to the MK 60 to inform it that the brakes are being applied. If the signal is received during an ASC regulation then brake regulation is interrupted.



Wheel Speed Sensors (active)

With the introduction of the Teves DSC III MK60, active wheel speed sensors that operate on the principle of magnetoresistive effect are used for the first time on BMW vehicles.

The sensor element and evaluation module are two separate components within the sensor housing.



1. **Metal pulse wheel**
2. **Magnet**
3. **Sensor element**
4. **Evaluation module**
5. **Support for sensor element**
6. **Sensor wiring with weather boot**
7. **Ground contact ring**
8. **Fastening element**
9. **Sensor housing**
10. **Pick-up surface**

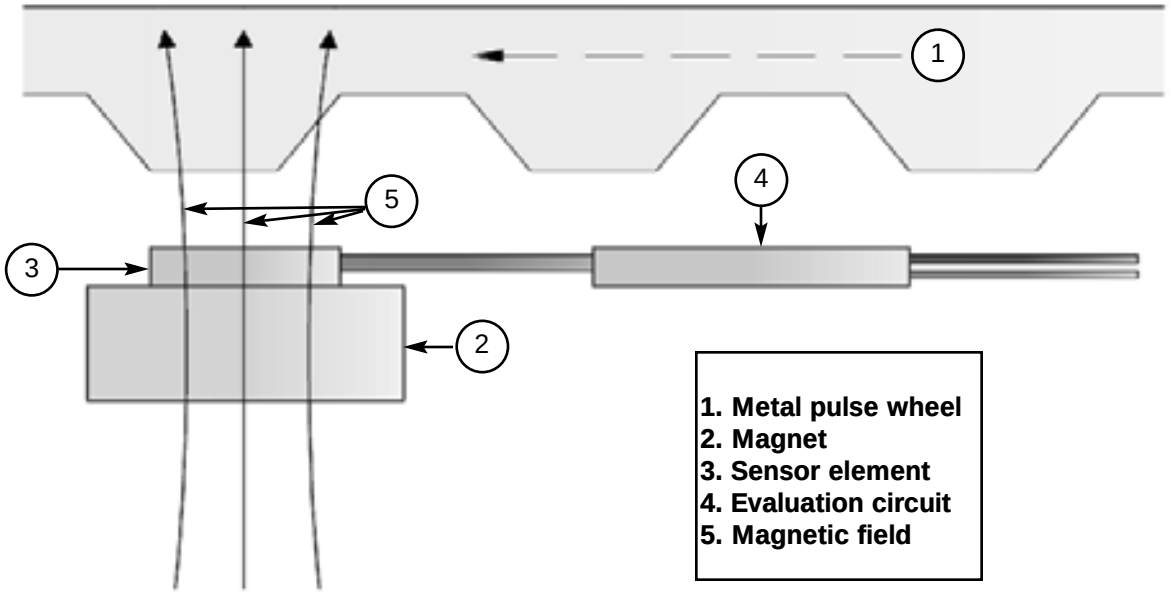
Principle of operation of the magnetoresistive sensor

The active sensing of the magnetoresistive sensor is particularly suitable for advanced stability control applications in which sensing at zero or near zero speed is required.

A permanent magnet in the sensor produces a magnetic field with the magnetic field stream at a right angle to the sensing element.

The sensor element is a ferromagnetic alloy that changes its resistance based on the influence of magnetic fields.

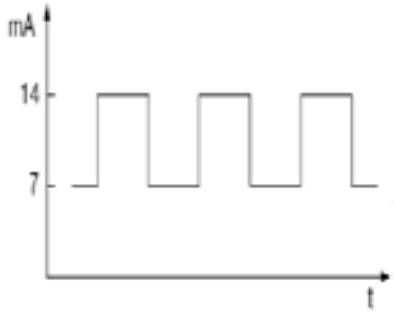
As the high portion of the pulse wheel approaches the sensing element, a deflection of the magnetic field stream is created. This causes the resistance to change in the thin film ferromagnetic layer of the sensor element.



The sensor element is affected by the direction of the magnetic field, not the field strength. The field strength is not important as long as it is above a certain level. This allows the sensor to tolerate variations in the field strength caused by age, temperature or mechanical tolerances.

The resistance change in the sensor element affects the voltage that is supplied by the evaluation circuit. The small amount of voltage provided to the sensor element is monitored and the voltage changes (1 to 100mV) are converted into current pulses by the evaluation module.

- Signal High-**14mA**
- Signal Low-**7mA**



The sensor evaluation circuit is supplied 12V by the MK60 control unit. Output voltage from the sensor is approximately 10V. The control unit counts the high and low current pulses to determine the wheel speed signal.

Front sensors are three wire because they have a separate ground wire.
Rear sensors are two wire and use the sensor case as a ground point.

Different sensors are used on the left and right side front axle of the vehicle. The difference comes in the length of the harness.

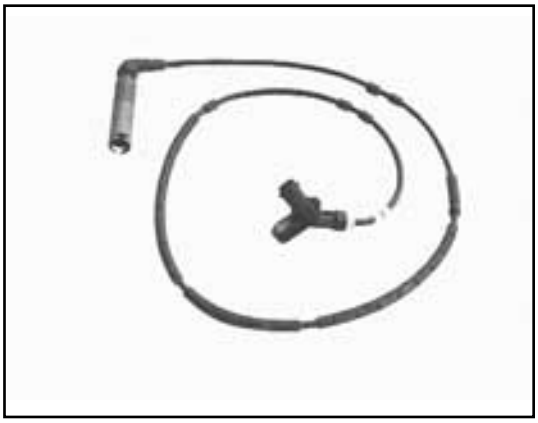
The connectors are blue to distinguish them apart from the grey connectors used for sensors on the MK20 EI.

The DSC III MK60 uses the same metal pulse wheels used with the MK20 inductive sensors.

Front axle E46/Z3

Rear axle Z3

Rear axle E46, short



There are two types of sensors used in the rear axle of the E46:

- The short sensor is used on the 325i (any transmission) and 330i automatic.
- The long sensor is used on the 330i manual transmission version.

The Z3 uses the same sensors for the rear axle, left or right.

Rotation Rate Sensor

The Rotation Rate Sensor is mounted on a metal bracket under the drivers seat. The sensor provides information to the MK60 concerning the vehicles speed around its main axis (yaw).

The sensor has a three pin connector with the following connections:

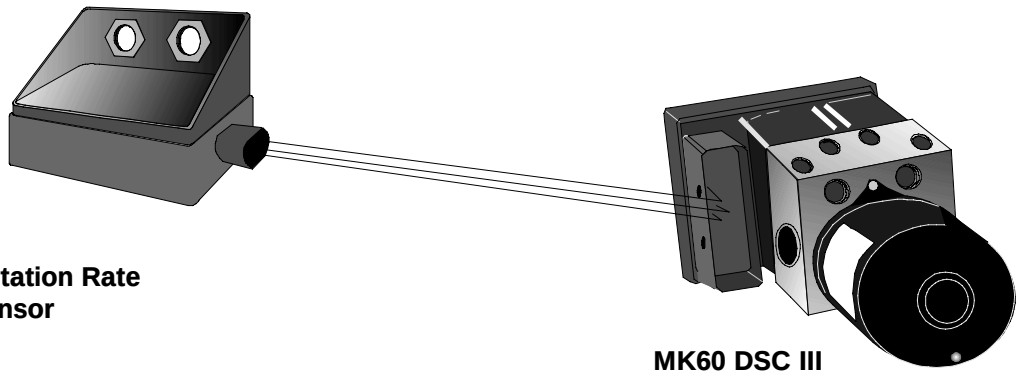
- 5V reference
- Signal
- Ground

The sensor receives a reference voltage of 5V from the MK60 control unit and provides a signal output of approximately 0.25 to 4.65V depending on the amount and direction of yaw. If the sensor is defective a constant voltage will be sent to the MK60.

The sensor element is a micro-mechanical double quartz tuning fork. A frequency of 11 Hertz is applied to one side of the fork and as the vehicle turns on it's axis, vibrations are induced on the other end.

The sensor analyzes the signal produced by the fork and produces an analog voltage signal that is proportional to the amount of yaw.

The rotation (yaw) rate is compared to the signal from the Steering Angle Sensor and the Transverse Acceleration Sensor. If physical limits are beginning to be exceeded, the MK60 DSC will begin regulation by engine and brake intervention to attempt to stabilize the vehicle. This is referred to as a GMR regulation.



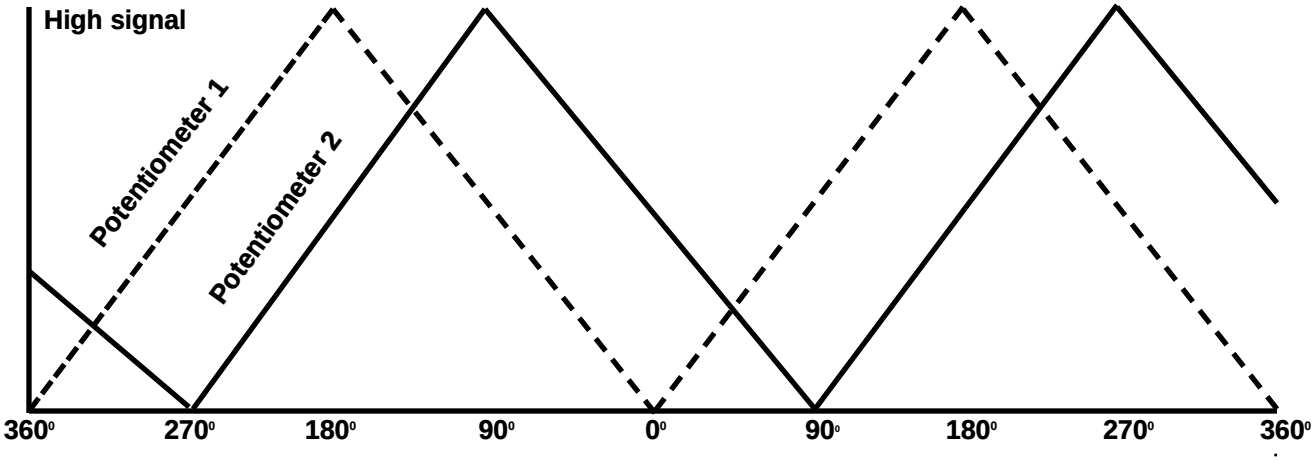
Rotation Rate Sensor

MK60 DSC III

The MK60 DSC III for M.Y. 2002 incorporates a combined Rotation rate and Transverse Acceleration Sensor. The Sensor is connected to the MK60 control unit by the CAN bus. The Z3 version will retain separate sensors until the E36/7 is replaced by the E46/6.

Steering Angle Sensor (LEW)

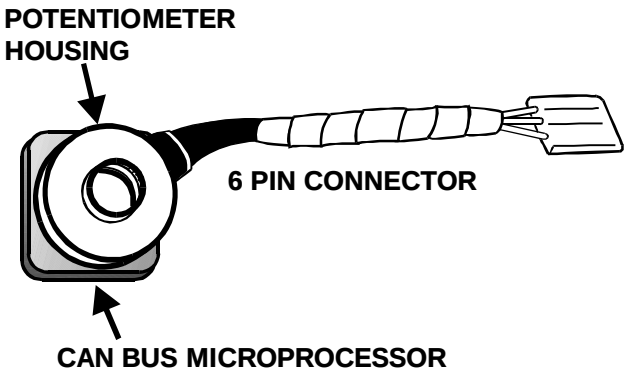
The Steering Angle Sensor is mounted towards the lower end of the steering column, above the flexible coupling. The LEW consists of a potentiometer and a built in microprocessor. The potentiometer has two pickups offset at 90° to one another. The raw potentiometer signal is processed and converted into a digital signal that is transmitted over the CAN bus to the MK60 DSC III control unit.



The sensor requires initialization in order to create a zero point default. Once initialized the LEW sends an ID number to the DSC control unit. The ID provides confirmation that the LEW is properly initialized.

The total steering wheel angle is determined by combining the CAN telegram signal, the stored zero point default and the actual number of turns to the wheel. In order to prevent the LEW from loosing count, KL 30 is provided to the sensor and it continues to record even after the ignition has been switched off.

The MK60 DSC III calculates the drivers desired rate of turn from the steering angle signal.



Pin 1. KL 30

Pin 2. KL 87

Pin 3. CAN high

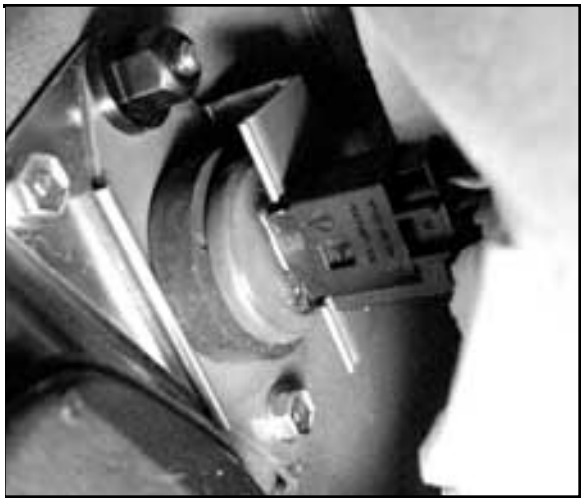
Pin 4. CAN low

Pin 5. KL 31

Pin 6. TXD

Note: Refer to the Workshop Hints for instructions on coding and initializing the sensor.

Transverse (Lateral) Acceleration Sensor



The Transverse Acceleration Sensor is mounted in the left “A” pillar behind the driver’s foot rest. The sensor provides the MK60 DSC control unit with a signal that corresponds to the degree of transverse acceleration (G forces) acting on the vehicle.

The sensor is a capacitive sensor with two plates. One plate is rigidly mounted, the other plate is mounted on a spring. Under the effect of transverse forces acting on the sensor the distance between the plates changes.

This change of distance between the plates affects the capacitance of the sensor. The evaluation circuitry converts the signal into an analog voltage that is transmitted to the control unit.

The output signal of the sensor is between the range of 0.5 to 4.5 Volts. This corresponds to -1.5 to 3.5g respectively. When the vehicle is stationary the output is 1.8V.

The transverse acceleration signal is used in the MK60 DSC III control unit along with the rotation rate and steering angle signal to determine if DSC regulation is required to maintain the vehicles stability.

Note: Refer to Workshop Hints for instructions on initializing sensor.

DSC Button

The DSC button is located on the SZM, however the SZM provides no processing, it is simply a housing for the button which is hardwired to the MK60 control unit.

The DSC Button features two functions that can be set by varying the time the button is held down for:

Button activation	Function	Display
Short press <2.5s	Only the yaw control of the DSC is deactivated. The ADB and DBC functions remain active. A higher slip ratio is allowed up to 42 mph for the purpose of improving traction in slippery conditions. ASC uses different thresholds.	DSC light illuminated
Long press >2.5s	All ASC, ADB, DSC, GMR (yaw control) and DBC control functions are deactivated. Used for service and use on dynamometers.	DSC light and general brake warning light (yellow ABL) illuminated.

Pressing the button again returns the system to normal status. It is not possible to go directly from one function to the next without first returning to normal status.

Instrument Cluster Warning Indicators

Three warning indicator lamps are arranged in the instrument cluster:

- DSC lamp: Indicates fault in DSC or system disabled by the switch.
- ABS lamp: Indicates a fault in the ABS system.
- ABL“BRAKE” lamp: This lamp is a general brake warning and illuminates two different colors.
    - Red indicates low brake fluid or hand brake engaged.
    - Yellow indicates DSC/ABS fault or system disabled by the switch.

The DSC and yellow ABL lamp are controlled by the MK60 DSC III control unit via the CAN bus. The ABS lamp is controlled directly by the MK60 via hardwire.

Hand brake Switch

The hand brake switch is an input to the MK60 DSC to cancel MSR regulation.

Principle of Operation

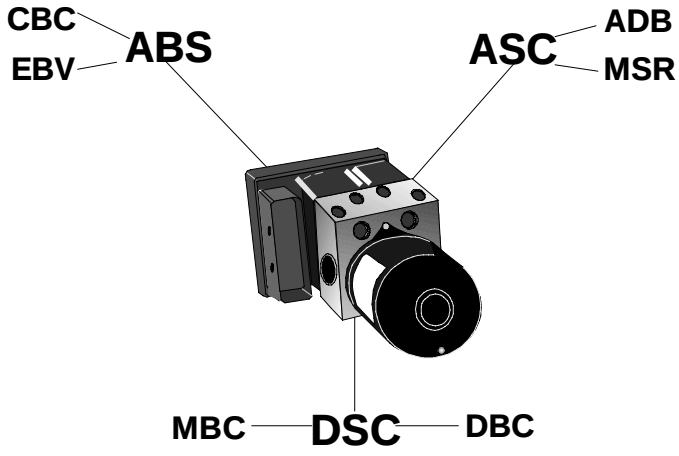
The scope of control for the MK60 DSC III is comprised of three systems:

- ABS
- ASC+T
- DSC

Based on signals coming from the various sensors, the MK60 DSC III will determine which system is best suited to maintain control of the vehicle.

In addition to the three basic systems, there are several sub-functions which are activated during very specific circumstances. The sub-functions are:

- CBC
- EBV
- MSR
- ADB
- DBC
- MBC



System: Anti-Lock Braking System (ABS)

The ABS system can prevent wheel lock when braking by comparing the four active wheel speed sensors to the average vehicle speed. If a wheel is locking during braking or has dropped below a speed threshold programmed in the control unit ABS braking will begin. ABS braking is possible when vehicle speeds are above 12 kph (7mph).

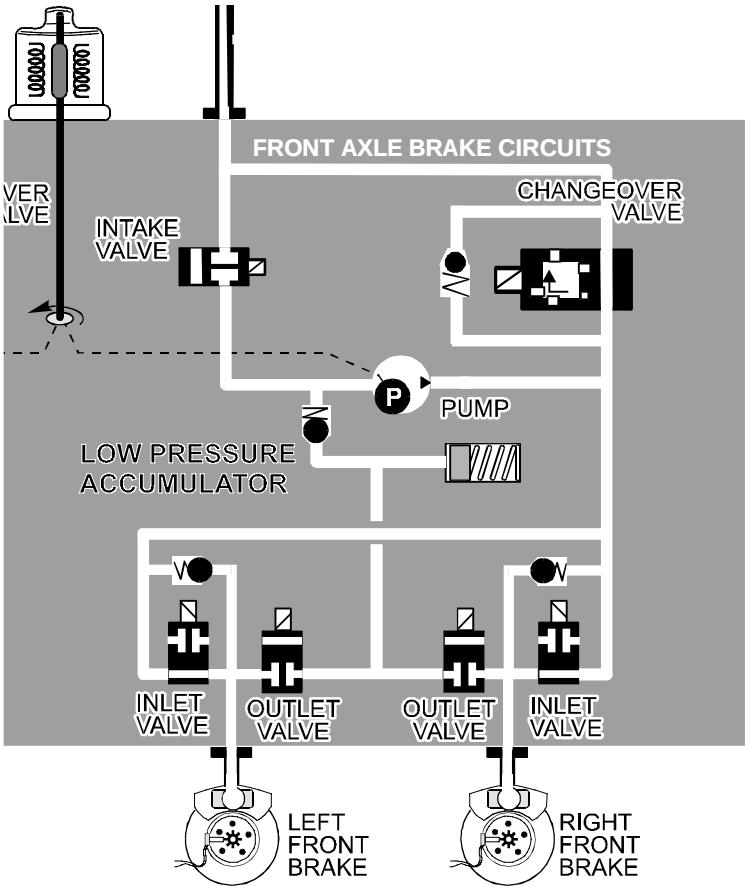
ABS regulation has three phases:

- Pressure Build
- Pressure Hold
- Pressure Release

Pressure Build already occurs during normal braking, so when ABS first intervenes it will start holding pressure by energizing the Inlet Valve. For example, if the right rear wheel is locking up, both Inlet Valves will be energized, regulating both wheels together. This logic is known as Select Low. Front wheels can be regulated individually as needed to prevent lockup.

Energizing the Inlet Valve closes the brake fluid passage to the calipers and traps the fluid at the current pressure, thus not allowing the brake pressure to rise any further.

If the wheel speed does not increase the Pressure Release phase begins.



Pressure Release occurs when the control unit energizes the Outlet Valve while continuing to hold the Inlet Valve closed. The trapped brake fluid is released out of the calipers, reducing braking pressure.

At the same time, the pump is switched on which draws in the released brake fluid and pumps it back into the pressure-build circuit restoring the volume of brake fluid again in front of the Inlet valve.

Depending on conditions the ABS system may cycle between these three phases from 3 to 12 times a second to prevent wheel lock.

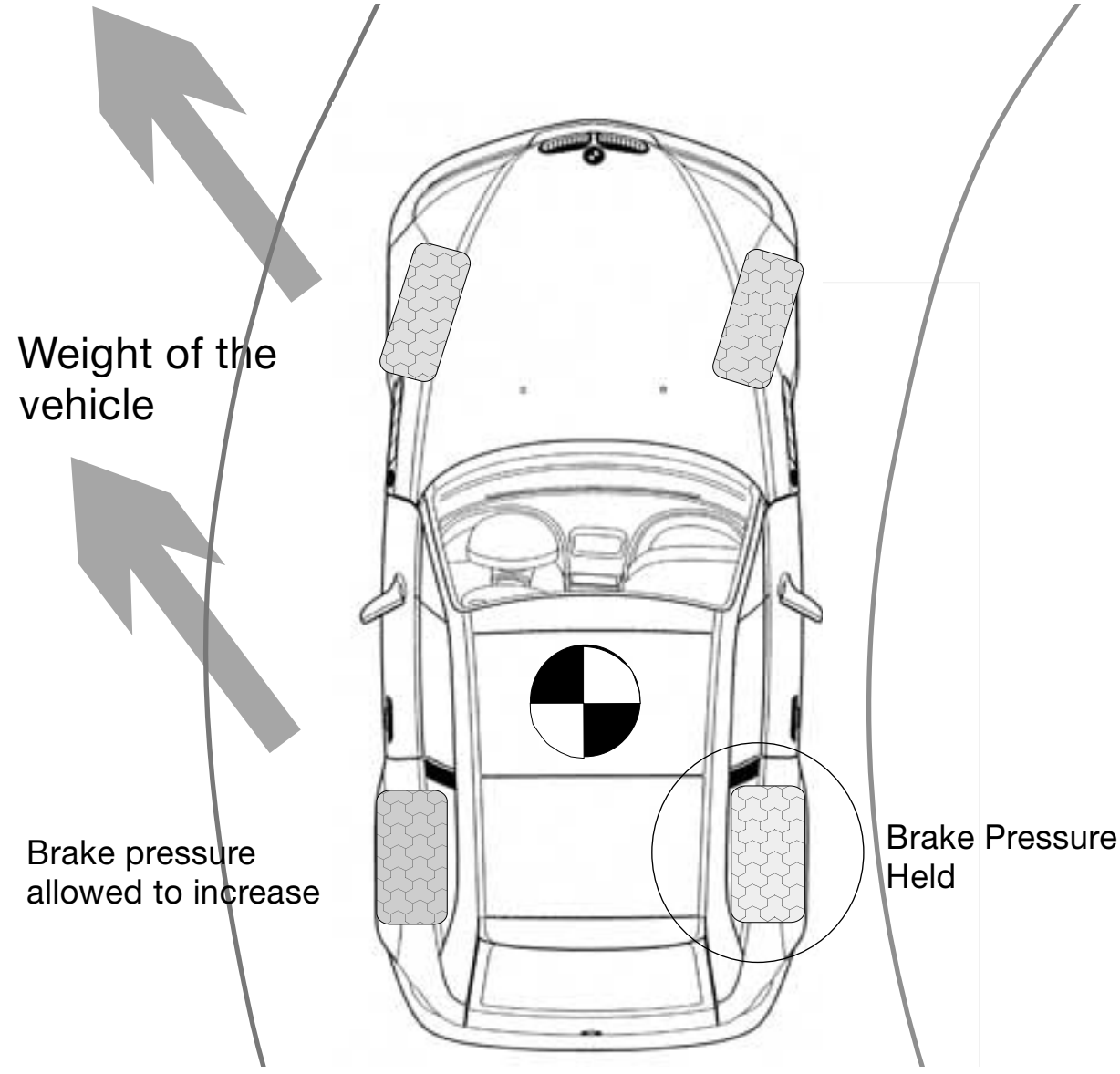
ABS Sub-functions

Corner Brake Control (CBC)
CBC can occur if the vehicle is cornering and ABS regulation is not taking place.

If the control unit detects transverse acceleration in excess of 0.6g and the brakes are applied, CBC prevents a build up in brake pressure to the inside rear wheel. This prevents the vehicle from entering into an unstable situation that can lead to **Oversteer**.

The MK60 accomplishes this by closing the Inlet Valve, thus not allowing brake pressure to increase at the brake caliper.

The difference in braking force between the two rear wheels creates a yaw force that opposes the oversteer and allows the vehicle to handle **neutrally**.



Electronic Brake Force Distribution (EBV)

EBV will adjust brake pressure to the rear axle based on the rate of slow-down of the rear wheels, ensuring even brake force between the front and the rear of the vehicle.

The control unit monitors the wheel speed when the brakes are applied and compares the deceleration of the front and rear axle to determine required regulation.

If the vehicle is moderately to fully loaded, the rear axle will take longer to slow down, rear wheel brakes can then be applied at a higher pressure .

If a vehicle was lightly loaded, a similar brake pressure would be too great and result in an unstable situation.

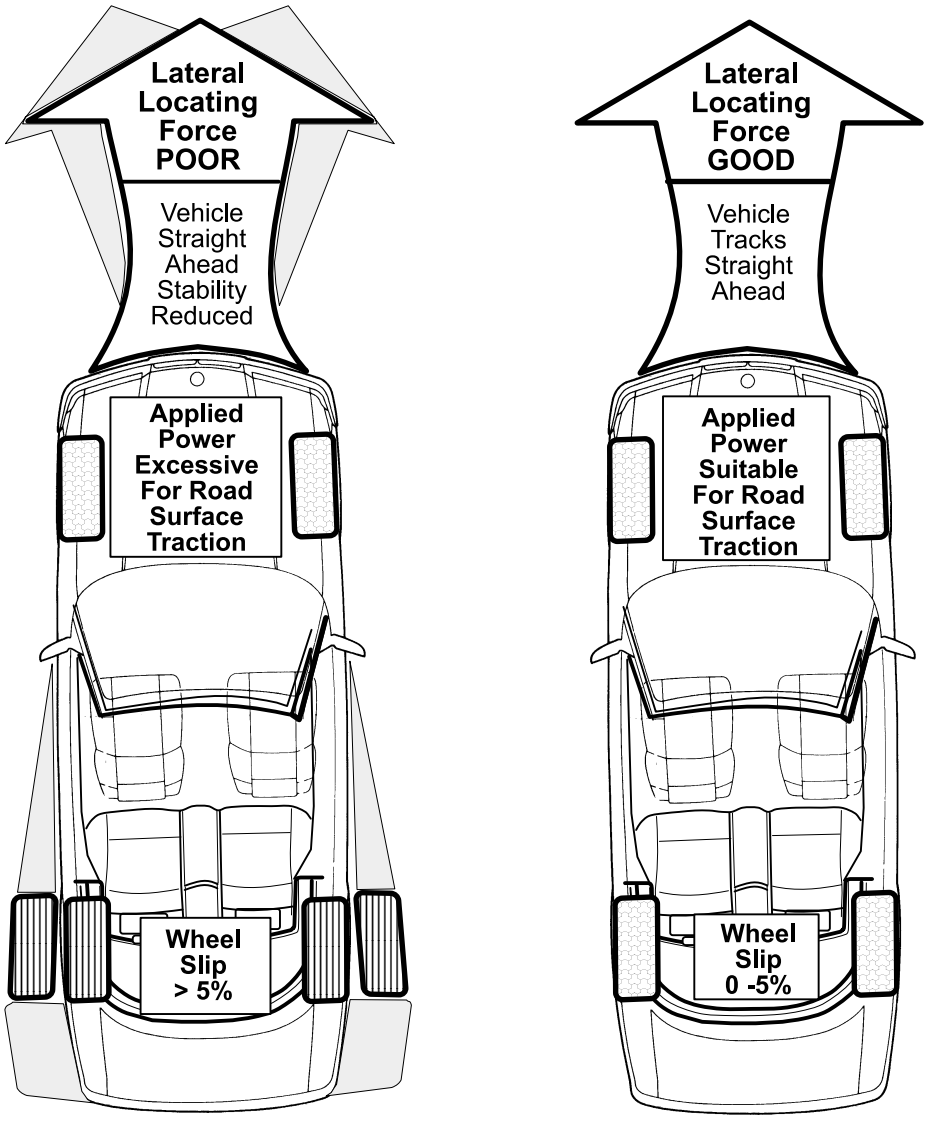
If EBV control intervention is required, the control unit cycles the inlet valve on the rear brake calipers to prevent further build-up.

Benefits of EBV are:

- Enhanced braking due to even distribution of brake force.
- Rear wheel brake size can be increased.
- Front and rear brakes wear at a similar rate.

Automatic Stability Control (ASC+T)

Based on input from the wheel speed sensors, the MK60 control unit determines if the vehicle is loosing traction due to excessive longitudinal (straight line) wheel slip. An ASC regulating sequence is initiated if the wheel slip exceeds the control units stored allowable values.



A critical slip ratio of up to 5% between the wheels will cause the traction control regulation to begin. This slip ratio is established when the system detects a wheel spin difference of 2MPH or greater.

ASC regulation is cancelled at any time if the brake pedal is applied.

The MK60 can control longitudinal wheel slip by two means:

- Engine Intervention
- Brake Intervention **(ADB, drive wheels only)**

Engine Intervention
Engine torque may be reduced by:

- Reducing the throttle opening angle
- Retarding the ignition
- Canceling individual cylinders by fuel injection cutout.

The MK60 DSC III control unit determines the amount of torque reduction that is necessary and sends the request for regulation to the DME via the CAN bus.

Brake Intervention (ADB)
Brake intervention is applied to the individual drive wheel which is loosing traction by regulating the brake calipers in three phases:

- Pressure Build
- Pressure Hold
- Pressure Release

When brake intervention is necessary, the front wheels must be isolated from the Pressure Build sequence in the hydraulic unit.

Here is an example of an ASC brake intervention at the left rear wheel:

- The Changeover Valve for the rear brake circuit, the right rear and both front Inlet Valves are energized and closed.
- The rear brake circuit Intake Valve is energized and opened.
- The Return/Pressure pump is activated and draws brake fluid through the open Intake Valve from the Master Cylinder **(via the Central Valve)** and delivers the pressurized fluid to the open Inlet Valve braking the left rear wheel.
- Pressure Hold and Pressure Release are done by cycling the Inlet and Outlet Valves similar to the ABS sequence described previously.

The control unit decides which regulation method should take place based on input criteria and chooses from two regulating principles:

- Select-High
- Select-Low

Select-High Regulation
In a Select-High regulation, the MK60 control unit selects the drive wheel with the **highest** amount of traction and uses it as the basis for evaluation.

- Engine torque is reduced slightly by request to the DME.
- The wheel with the **least** amount of traction is braked. This allows a torque transfer to the wheel with the higher amount of traction **(similar to a locking differential)**.

Select-High is used if the vehicle speed is below 40 kph (25 mph).

Select-Low Regulation
In a Select-Low regulation, the MK60 control unit selects the drive wheel with the **lowest** amount of traction and uses it as the basis for evaluation.

- Engine torque is reduced until the wheel slip is no longer present.
- Brake regulation is **not** carried out.

Select-Low is used if the vehicle speed is above 40 kph (25 mph).

ASC Sub-functions

Engine Drag Torque Reduction (MSR)
If the vehicle is driven in low gear when coasting down hill, or if there is a sudden shift to a lower gear, the wheels may be slowed by the engine's braking effect too rapidly. This could result in an unstable situation.

If the front wheels are turning faster than the rear wheels, the MK 60 control unit signals the DME via the CAN bus to **raise** the engine torque. DME cancels fuel cut-off and allows the engine speed to increase, this allows the drive wheels to accelerate to match the speed of the non-driven wheels.

MSR regulation is cancelled if the brake pedal or hand brake are applied.

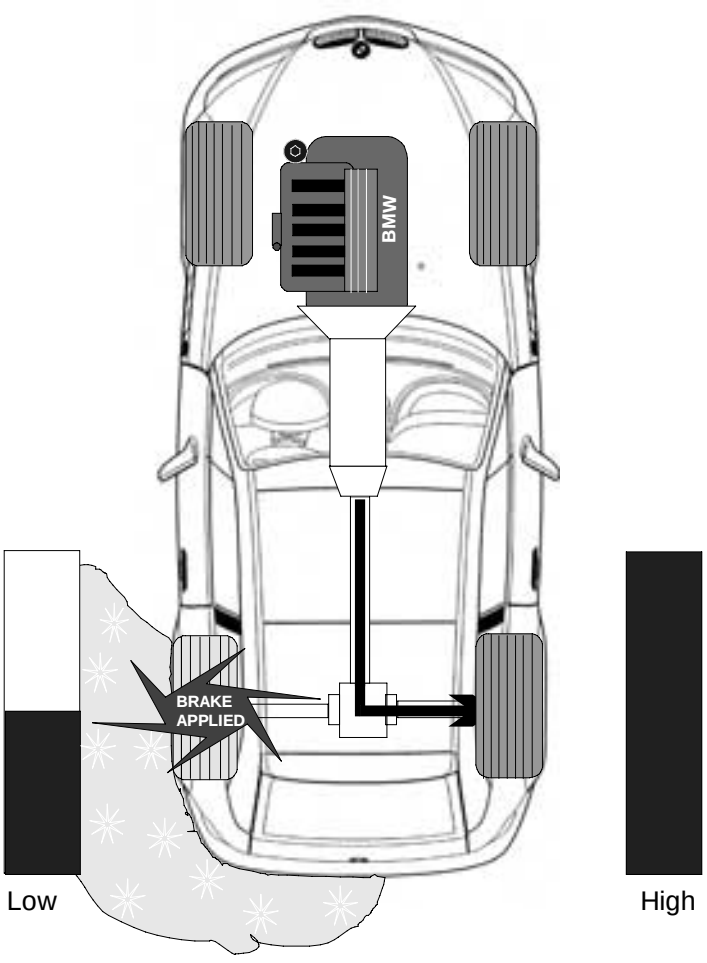
Modified ADB function (2-wheel drive vehicles equipped with MK60)

The ADB is an automatic differential lock that improves traction. The slipping wheel is braked by pressure built up in the hydraulic unit. The drive torque can be transferred to the wheel with the greater traction, which can transmit drive power to the road. This function takes the place of a limited slip differential.

The MK60 DSC III system incorporates two methods of ADB based on the DSC switch input to the control unit. With the system “on” the ADB works with engine intervention at a threshold of below 40kph(24 mph).

Tapping the DSC switch (<2.5 s) increases the slip threshold of the ADB up to approximately 70 kph (42 mph) for the purpose of increasing traction.

This feature is also helpful for example when rocking a vehicle out of mud or snow.



Coefficient of friction

Dynamic Stability Control (DSC)

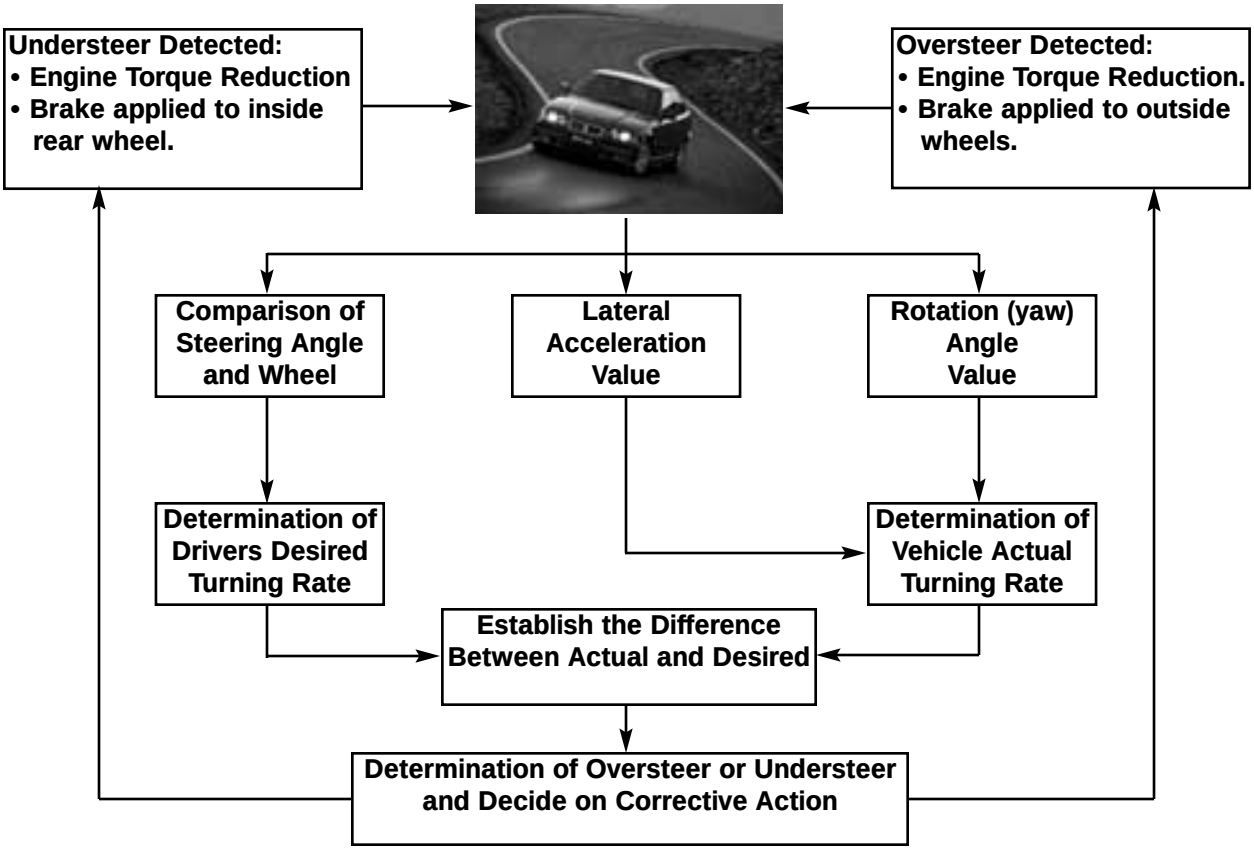
With the introduction of DSC systems, lateral dynamics were taken into account for the first time. The MK60 DSC III system will initiate a DSC regulation sequence if the control unit detects a difference between the drivers desired turning angle and the actual rotation angle of the vehicle. The control unit determines vehicle stability based on:

- Steering wheel angle
- Wheel speed
- Transverse acceleration forces
- Rotation angle and speed (yaw)

Once the control unit determines that the vehicle is in an unstable situation, it also identifies whether it is oversteering or understeering. This distinction is important because it determines which control strategy should be used to help stabilize the vehicle.

DSC regulation consist of :

- Engine intervention
- Engine and brake intervention **(any wheel)**
- Brake intervention



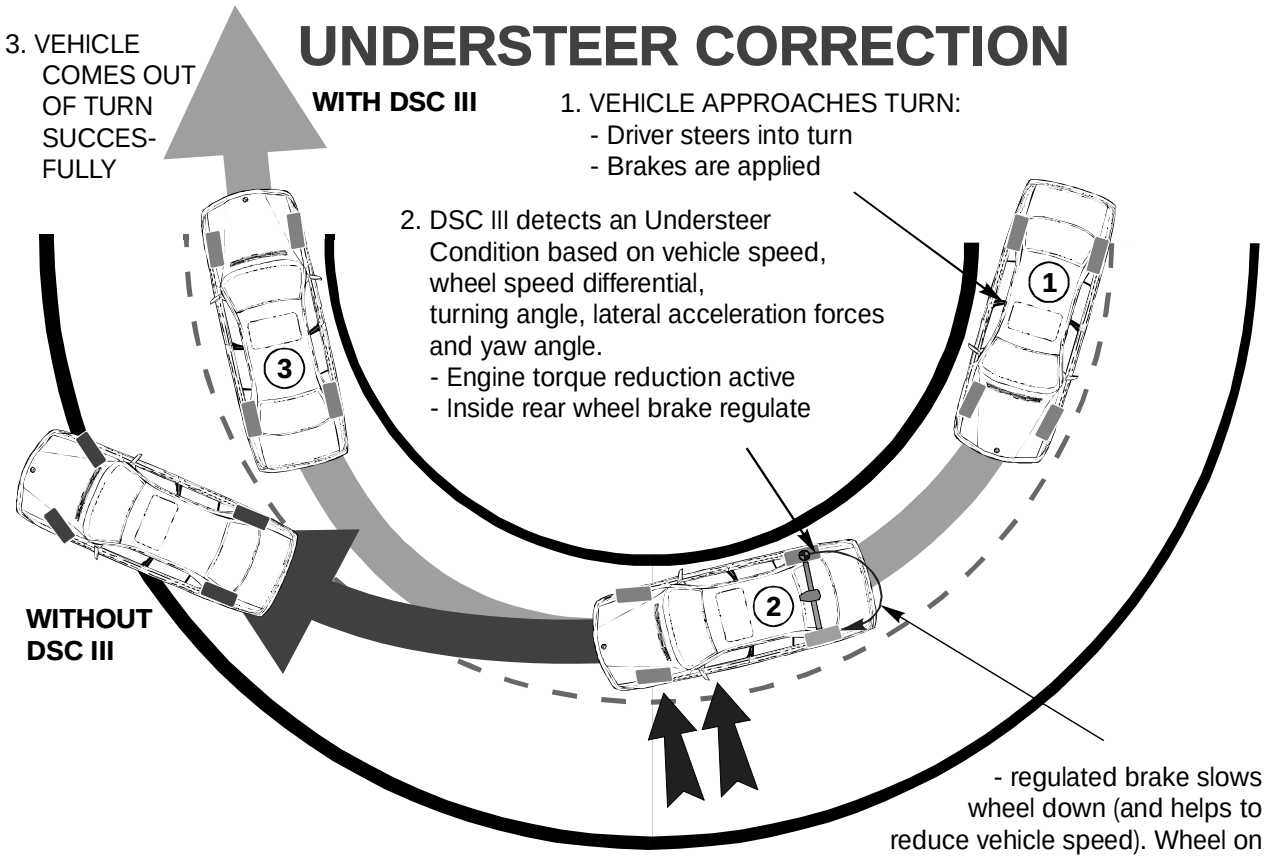
Understeer
Understeer occurs when the driver wishes to turn a corner but despite the front wheels being turned in the direction of the curve the vehicle continues its track forward. This occurs when the front wheels no longer have sufficient lateral locating force (traction).

The MK60 DSC III can identify the situation and initiate a corrective action based on engine torque reduction followed by a controlled brake intervention sequence if needed.

Engine torque reduction is carried out by the DME from a request by the DSC via the CAN bus. The DME telegrams the torque reduction confirmation back to the DSC.

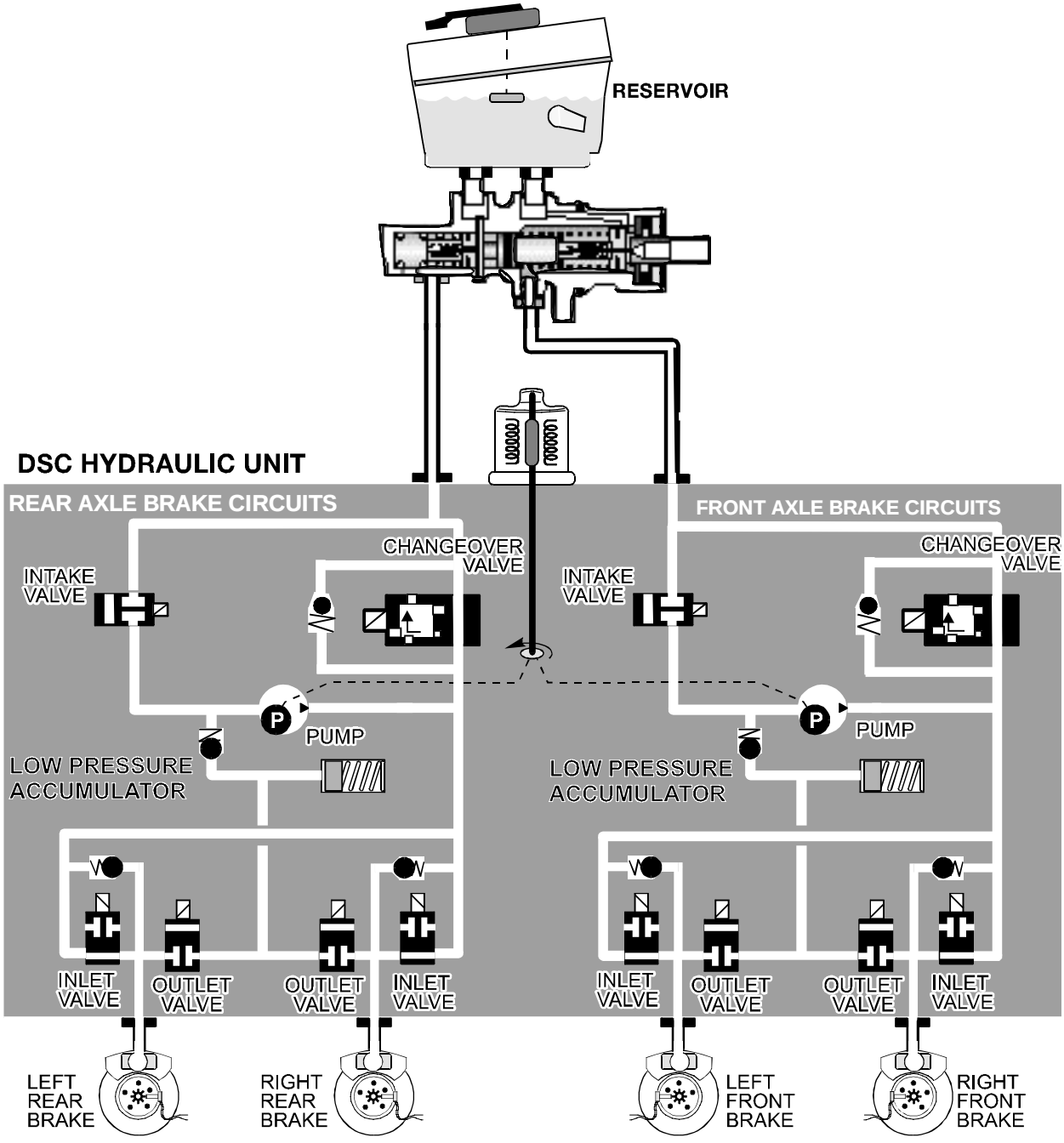
Brake intervention is carried out by the MK60 hydraulic unit if the driver is not actively braking. An example of a brake intervention at the inside rear wheel is as follows:

- All Inlet Valves are closed except for the right rear inlet.
- Intake Valve for rear circuit is opened.
- Both Changeover Valves are closed.
- Return pump operated.



Just as an ASC regulation, DSC brake intervention carries out:

- Pressure Build
- Pressure Hold
- Pressure release

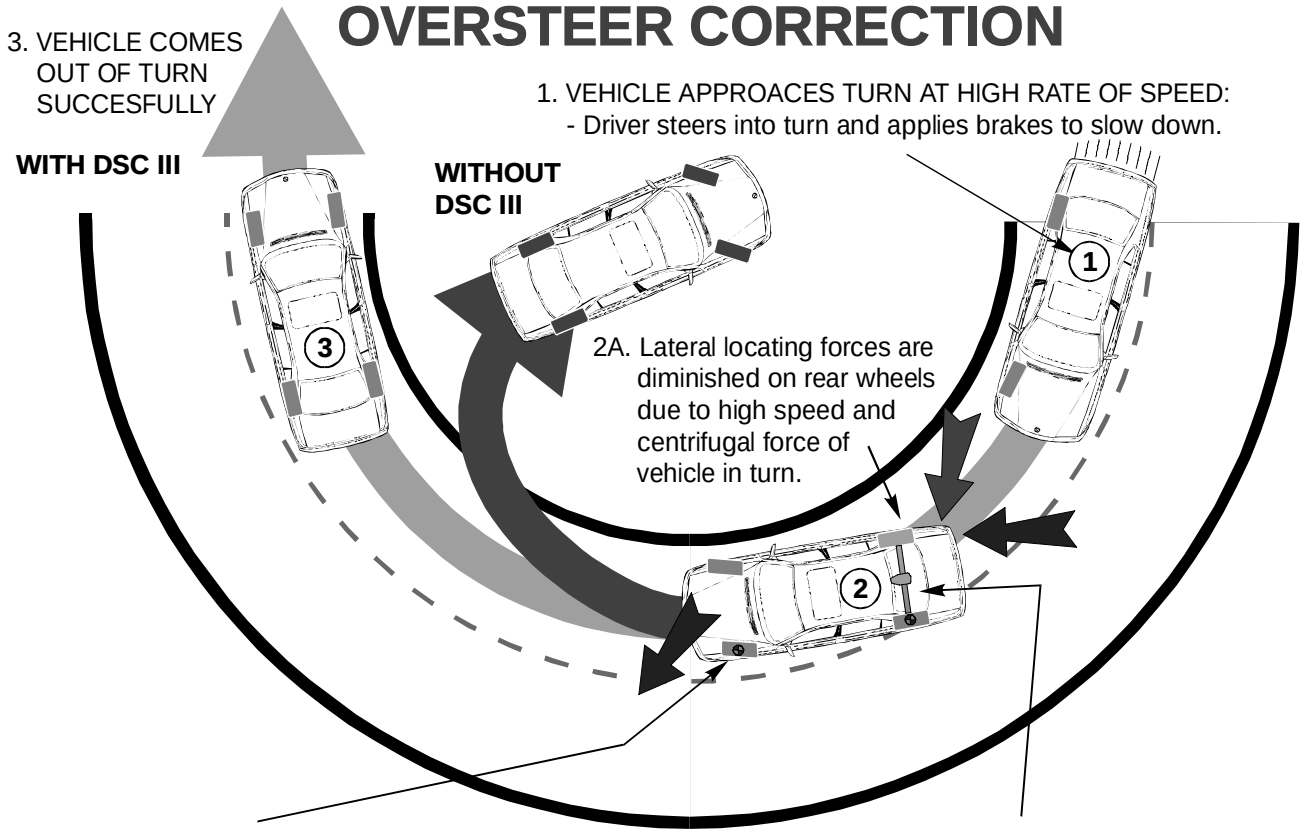


Oversteer

Oversteer occurs when the driver wishes to turn a corner and the tail of the vehicle slides outward leading the turn. This is caused by the rear tires loosing traction and not being able to hold against the centrifugal force acting upon the vehicle.

The MK60 DSC III can identify the situation and initiate a corrective action based on engine torque reduction followed by a controlled brake intervention sequence if needed.

Engine torque reduction is carried out by the DME from a request by the DSC via the CAN bus. The DME sends the torque reduction confirmation back to the DSC.



2D. The torque reduction and rear brake regulation should stabilize the vehicle at this point. If not the left front wheel has a high degree of lateral locating force and is momentarily regulated.

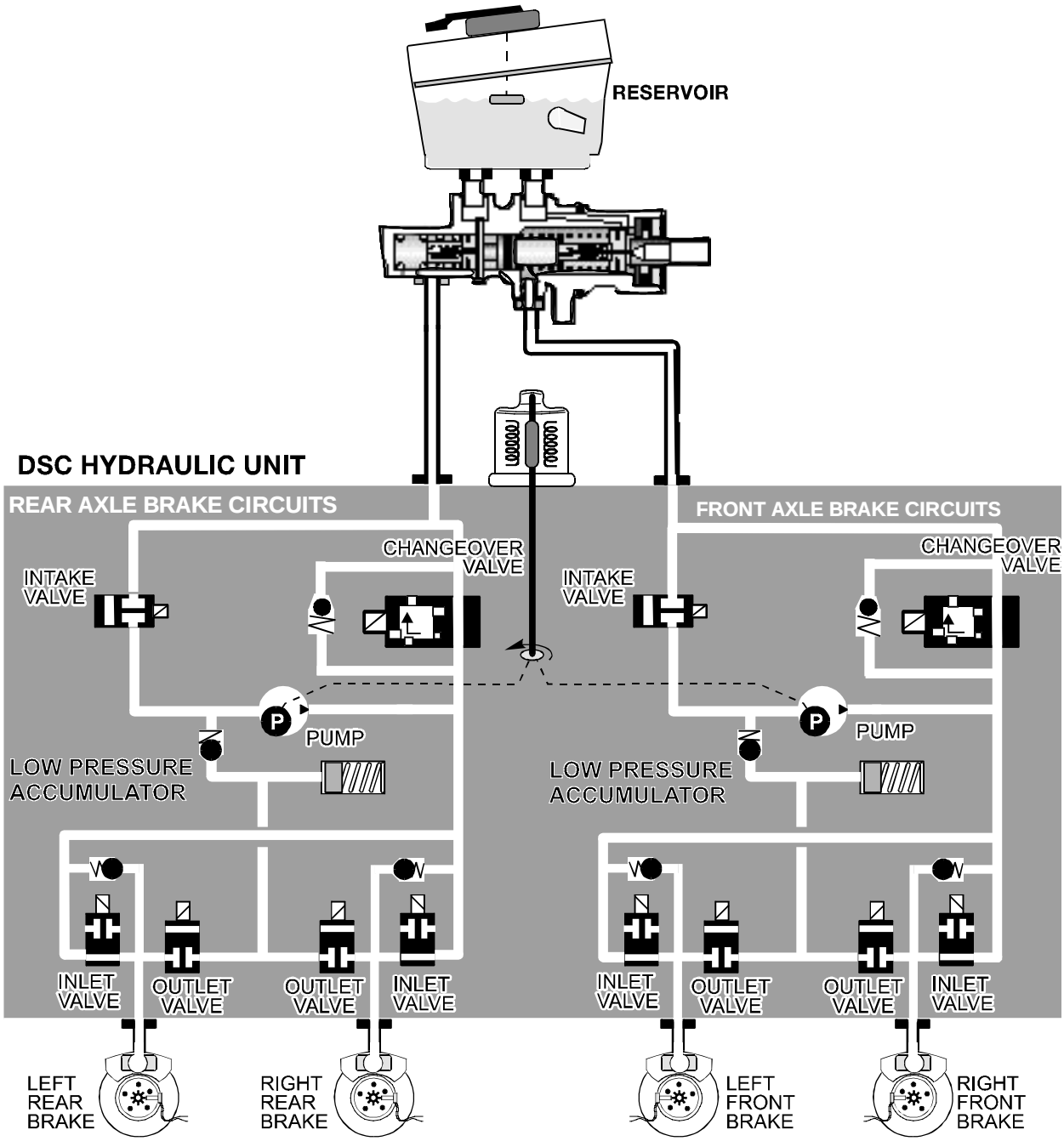
This action deliberately causes the wheel to shed a calculated degree of it's locating force. This counteracts oversteer yaw at this wheel and also aids in slowing the vehicle down to correct it.

2B. Driver tries to compensate by oversteering which diminishes lateral locating force even further. Simultaneously, rear of car starts to slide out.

2C. DSC III determines an OVERSTEER condition. Engine torque is reduced via CAN Bus signalling. Outside rear wheel is momentarily regulated to counteract severe yaw angle (also helps to reduce drive torque further.)

Brake intervention is carried out by the MK60 hydraulic unit if the driver is not actively braking. An example of a brake intervention at the left outside wheel is as follows:

- All Inlet Valves are closed except for the left rear inlet.
- Intake Valve for rear circuit is opened.
- Both Changeover Valves are closed.
- Return pump operated.



DSC Sub-functions

Dynamic Brake System (DBS)

DBS is designed to assist the driver in emergency braking situations by automatically increasing pressure to the vehicles brake system. This allows the vehicle to stop in the shortest distance possible. DBS was first available in 1999 Bosch DSC III 5.7 systems. It is available on a Continental Teves system for the first time with MK60 DSC III.

The DBS system contains two functions: Dynamic Brake Control and Maximum Brake Control. DBS functions are programmed into the MK60 control unit and require no additional hardware over conventional DSC.

Dynamic Brake Control (DBC)

The DBC function is designed to provide an increase in braking pressure up to the ABS threshold during rapid (emergency) braking situations. The MK60 control unit monitors the inputs from the brake light switch and the brake pressure sensors on the master cylinder. The triggering criteria for activation of DBC is, how rapidly is the brake pressure increasing with an application of the brake pedal. The triggering conditions are:

- Brake light switch on.
- Brake pressure in the master cylinder above threshold.
- Brake pressure build-up speed above threshold.
- Vehicle road speed above 3mph (5kmh).
- Pressure sensor self test completed and sensors not faulted.
- Vehicle traveling forward.
- Not all of the wheels in ABS regulation range.

If the threshold for DBC triggering is achieved, the MK60 control unit will activate a pressure build-up intervention by activating the return pump. The pressure at all wheels is increased up to the ABS regulation point. This ensures that the maximum brake force is applied to the vehicle.

During DBC the rear axle is controlled with Select-Low logic and the front wheels are regulated individually. DBC will continue until:

- The driver releases the brake pedal.
- Brake pressure falls below threshold.
- Vehicle road speed below 3mph.

DBC will also be switched off if a fault occurs in with any of the necessary input sensors. A fault in DBC will illuminate the “BRAKE” (ABL) lamp yellow to warn the driver, depending on the type of failure the DSC lamp may be illuminated as well.

Maximum Brake Control (MBC)
The MBC function is designed to support driver initiated braking by building up pressure in the rear brake circuit when the front wheels are already in ABS regulation.

The additional braking pressure is applied to bring the rear wheels up to the ABS regulation point shortening the stopping distance. The MBC function is triggered when the brakes are applied more slowly than the threshold needed for a DBC regulation. The triggering conditions are:

- Both front wheels in ABS regulation.
- Vehicle road speed above 3mph (5kmh).
- DBC and pressure sensor initialization test successful.
- Vehicle traveling forward.
- Rear wheels not in ABS regulation.

If the threshold for MBC triggering is achieved, the MK60 control unit will activate a pressure build-up intervention by activating the return pump. The pressure at the rear wheels is increased up to the ABS regulation point. This ensures that the maximum brake force is applied to the vehicle.

The MBC function will be switched off if:

- Front wheels drop out of ABS regulation.
- The driver releases the brake pedal.
- Brake pressure falls below threshold.
- Vehicle road speed below 3mph.

MBC will also be switched off if a fault occurs in with any of the necessary input sensors. A fault in MBC will illuminate the “BRAKE” (ABL) lamp yellow to warn the driver, depending on the type of failure the DSC lamp may be illuminated as well.

Workshop Hints

Diagnosis

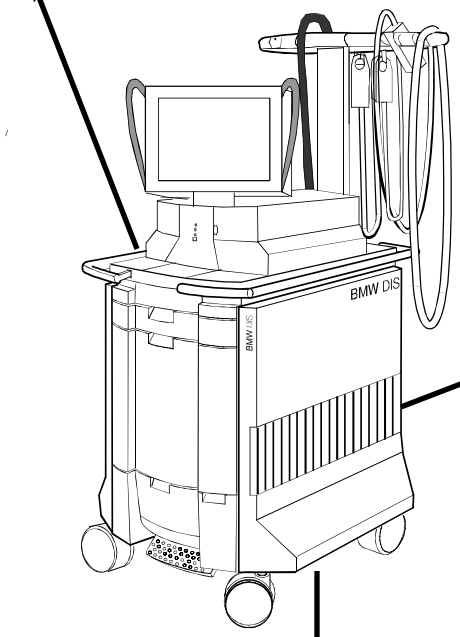
Diagnosis of the MK60 DSC lll is carried out using the DISplus or MoDiC

Control Unit Functions:
Expert mode diagnosis available at any time during troubleshooting. To enter: press the Control Unit Functions button at the right lower corner of the screen.

The contents are:
- **Identification**
- **Delete Fault Memory**
- **Read Fault Memory**
- **Component Activation**
- **Status queries (requests)**

Service Functions:
Provides access to specialized test modules used as post repair procedures. To enter:
- Function Selection
- Service Functions
- Chassis
- Dynamic Stability Control MK60

The contents are:
- **Connection Speed Sensor:** A test to verify the proper wiring to the wheel speed sensors
- **Connection Brake Lines:** A test to verify the proper brake pipe connections to the hydraulic unit.
- **Adjustment Functions:** Test modules to initialize certain components after repair work is performed
  - Steering Angle Sensor
  - Lateral Acceleration Sensor
  - Pressure Sensors

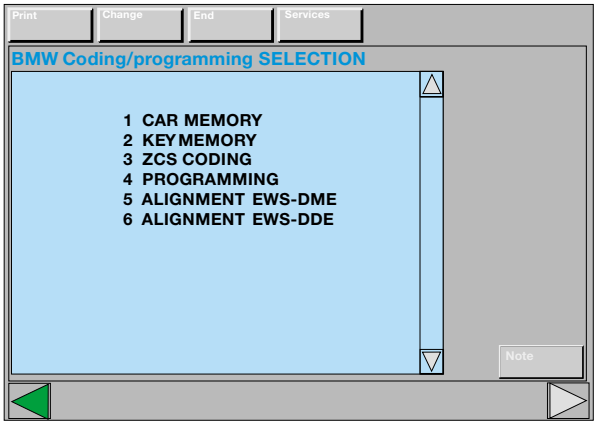


Test Modules: Faults with the MK60 system can be diagnosed using fault or symptom driven test modules. To begin diagnosis:
- **Perform the Quick Test.**
- **Select Vehicle Symptom from the Symptom Selection page.**
- **Select Test Module from Test Plan page.**
- **Press the Test Schedule Button.**

Test Modules are configured in the E46 diagnosis concept.

Coding

Coding must be performed after replacement of the MK60 control module or the steering angle sensor. ZCS coding is found in the Coding and Programming selection from the start screen or when pressing the Change button. Follow on-screen instructions for initialization of components after completing the coding process.



Adjustment Functions

Adjustment (initialization) is required when:

- Replacing the MK60 Control Unit.
- Replacing/Re-coding the Steering Angle Sensor.
- Replacing one or both Brake Pressure Sensors.
- Replacing Lateral Acceleration Sensor.

Steering Angle Sensor

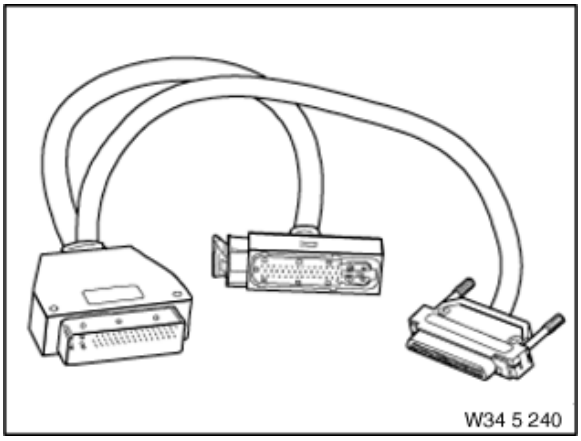
The steering angle sensor requires an offset adjustment after the sensor has been replaced, coded or after repairs to the steering or suspension system. The offset adjustment informs the steering angle sensor processor of the straight ahead position of the front wheels.

The adjustment is performed by completing the Test Module found in Service Functions. Once the adjustment is complete the sensor sends an identification number over the CAN bus to the DSC control unit. The ID provides confirmation that the steering angle sensor is coded and has successfully completed the adjustment procedure.

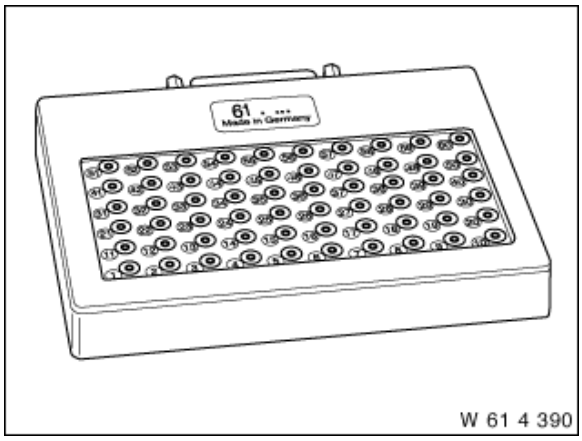
Special Tools

Special Tools available for the Teves DSC III MK60 consist of:

47 Pin V-Cable 34 5 250



60 Pin Break-Out-Box



Traction and Stability Control Systems Application Chart

	E36	Z3/Coupe	E46	E39	E38	E53	E52
1998MY	ASC+T	ASC+T MK IV G	N/A	9/97 ASC+T5 S: 528i DSC III 5.3 S: 540i N/A 528i	9/97 DSC III 5.3 S: 740i/il S: 750iL	N/A	N/A
1999MY	ASC+T MK IV G 328iC/318ti	ASC MK20 EI except M versions ASC +T MK IV M/coupe/roadster	ASC MK20 EI	9/98 ASC+T5 S: 528i DSC III 5.7 S: 540i O: 528i	3/98 DSC III 5.7 S: 740i/iL S: 750iL	N/A	N/A
2000MY	N/A	From 4/99 MK20 DSC III	6/99 MK20 DSC III	6/99 DSC III 5.7 Standard all models	3/99 DSC III 5.7 Standard all models	9/99 DSC III 5.7	1/00 DSC III 5.7
2001MY	N/A	From 9/00 MK60 DSC III M-versions MK 20 DSC III	From 9/00 MK60 DSC III M3 MK20 EI E46/16 All wheel drive DSC III 5.7	DSC III 5.7	DSC III 5.7	DSC III 5.7	DSC III 5.7

S = STANDARD EQUIPMENT
O = OPTIONAL EQUIPMENT

Review Questions

1. Name the important changes made to the MK60 from the previous MK20EI?

2. Why is a pre-charge pump not required?

3. What is the purpose of the two sensors on the master cylinder and what is their relationship to the BLS?

4. What is the difference of the signal produced by the magnetoresistive and a Hall-effect wheel sensor?

5. Describe the function of the DSC button in the MK60 system?

6. List the various sensors used to detect oversteer/understeer in the DSC system.

7. What is the purpose of the DBS sub-function?